CLAIMS

1. A method of synthesising germanium sulphide using chemical vapour deposition, comprising:

(i) providing a gas mixture containing germanium tetrachloride ($GeCl_4$) and hydrogen sulphide (H_2S); and

(ii) passing the gas mixture into a reaction chamber that is operated to provide a reaction temperature of between 450-700°C for the reaction:

$$GeCl_4 + 2H_2S \Rightarrow GeS_2 + 4HCl$$

thereby synthesising germanium sulphide in solid form and hydrogen chloride in gaseous form as a byproduct.

2. The method of claim 1, wherein the germanium sulphide is deposited as a glass film on a substrate arranged in the reaction chamber.

3. The method of claim 1, wherein the germanium sulphide is deposited as a glass film on the inside of a hollow tube that is arranged in, or forms part of, the reaction chamber

4. The method of claim 2 or 3, wherein the composition of the glass film is varied during its deposition to provide a desired refractive index profile.

5. The method of claim 3 or 4, further comprising:

collapsing the reaction chamber to create an optical fibre preform in which the first glass film will form the cladding layer of the optical fibre and the second glass film will form the core.

6. The method of claim 5, further comprising:

drawing the optical fibre preform into an optical fibre.

7. The method of any one of claims 1 to 6, wherein the reaction chamber is operated to provide a reaction temperature of 500°C+/- 50°C to induce formation of the germanium sulphide in glass form through the reaction.

8. The method of any one of claims 1 to 6, wherein the reaction chamber is operated to provide a reaction temperature between the temperature of glass transition and the temperature of onset of crystallisation of germanium sulphide to induce formation of the germanium sulphide in glass form through the reaction.

9. The method of any one of the preceding claims, wherein the reaction chamber is a horizontal tube furnace.

10. The method of claim 1, wherein the germanium sulphide is deposited in crystalline form in the reaction chamber.

11. The method of claim 10, further comprising:

sealing the reaction chamber containing the germanium sulphide in crystalline form; and

heating the sealed reaction chamber to melt the crystalline form of the germanium sulphide and resolidify it into glass.

12. The method of claim 10 or 11, wherein the reaction chamber is operated to provide a reaction temperature of 650°C+/- 50°C to induce formation of the crystalline form of germanium sulphide through the reaction.

13. The method of claim 10 or 11, wherein the reaction chamber is operated to provide a reaction temperature between the temperature of onset of crystallisation

of germanium sulphide and its melting temperature to induce formation of the germanium sulphide in crystalline form through the reaction.

14. The method of any one of claims 10 to 13, wherein the reaction chamber is a vertical tube furnace.

15. The method of claim 1, wherein the gas mixture is directed through a nozzle to create a reactable spray in the reaction chamber, thereby to form molten droplets which then freeze to form spheres or microspheres of germanium sulphide.

16. The method of any one of the preceding claims, wherein the reaction chamber is maintained at a pressure close to atmospheric during the reaction.

17. The method of any one of claims 1 to 16, wherein the gas mixture is formed by:

providing a first gas stream of a carrier gas containing the germanium tetrachloride ($GeCl_4$);

providing a second gas stream of the hydrogen sulphide (H_2S); and

mixing the first and second gas streams prior to introduction into the reaction chamber.

18. The method of claim 17, wherein the carrier gas is an inert gas.

19. The method of any one of claims 1 to 16, wherein the hydrogen sulphide (H_2S) acts as a carrier gas for the germanium tetrachloride ($GeCl_4$).

20. The method of any one of the preceding claims, further comprising:

providing in said gas mixture one or more of the following metal chlorides:

TlCl	$NbCl_5$	$HfCl_4$	$BiCl_3$
$TeCl_4$	$NdCl_3$	AuCl	$BaCl_2$
$TaCl_5$	$MoCl_3$	$GeCl_4$	NaCl
$SiCl_4$	$HgCl_2$	$GdCl_3$	$AlCl_3$
Se_2Cl_2	$MnCl_2$	$ErCl_3$	PCl_3
$RuCl_3$	$MgCl_2$	$DyCl_3$	KCl
RbCl	$LuCl_3$	$CuCl_2$	$CaCl_2$
RhCl	LiCl	CuCl	$GaCl_3$
$PrCl_3$	$PbCl_2$	$CoCl_2$	$SnCl_3$
$PtCl_2$	$LaCl_3$	$CrCl_2$	$TmCl_3$
$PdCl_5$	$FeCl_3$	CsCl	YCl_3
$InCl_3$	$IrCl_3$	$CdCl_2$	$AsCl_3$
WCl_6	$HoCl_3$	$SbCl_3$	$ZrCl_4$
$TiCl_4$	$ZnCl_2$	VCl_4	AgCl

in order to modify the germanium sulphide being synthesised.

21. A compound of germanium sulphide obtained by the method of any one of claims 1 to 20.

22. A compound of germanium sulphide obtainable by the method of any one of claims 1 to 20.

23. A compound of germanium sulphide in which transition metal impurities are present at levels of less than 1 ppm.

24. A compound of germanium sulphide in which transition metal impurities are present at levels of less than 0.1 ppm.

25. A compound of germanium sulphide in which carbon impurities are present at levels of less than 1 ppm.

26. A compound of germanium sulphide in which oxygen impurities are present at levels of less than 1000 ppm.

27. A compound according to any one of claims 21 to 26 including as modifiers one or more of the following elements: P, Ga, As.

28. A compound according to any one of claims 21 to 27, including one or more of the lanthanide elements: Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yr, Lu.

29. A compound according to any one of claims 21 to 28, including one or more of the transition metal elements: Ti, V, Cr, Mn, Fe, Co, Ni, Cu.

30. A compound according to any one of claims 21 to 29, including one or more oxides of the following elements to increase the photosensitiviy of the compound: Sn, B, Na, Li, K, Ag, Au, Pt.

31. A compound according to any one of claims 21 to 30, wherein the compound is in glass form.

32. A compound according to any one of claims 21 to 30, wherein the compound is in crystalline powder form.

33. A glass thin film of the compound of any one of claims 21 to 30.

34. A bulk glass rod or element of the compound of any one of claims 21 to 30.

35. A planar waveguide comprising the compound of any one of claims 21 to 30.

36. An optical fibre waveguide comprising the compound of any one of claims 21 to 30.

37. The optical fibre waveguide of claim 36, wherein the compound is microstructured to form a holey optical fibre waveguide.

38. The waveguide of any one of claims 35 to 37, wherein the waveguide is monomode.

39. An active optical device comprising a waveguide according to any one of claims 35 to 38.

40. A passive optical device comprising a waveguide according to any one of claims 35 to 38.

41. A method of fabricating germanium sulphide substantially as hereinbefore described with reference to the accompanying drawings.

42. A germanium sulphide device substantially as hereinbefore described with reference to the accompanying drawings.